

BACKGROUND OF THE INVENTION

The present invention relates to an image processing apparatus and image processing method that control and manage code information for rendering, particularly code information for rendering characters, and an image forming apparatus that employs the image processing apparatus and image processing method.

FIG. 19 is a block diagram showing an example of a general image forming apparatus. On the rendering, the reference numeral 1 designates an input analysis unit; 2, a character data processing unit; 3, a graphics data processing unit; 4, an image data processing unit; 5, an intermediate code processing unit; 6, a band buffer; and 7, an output unit. The input forming apparatus shown in FIG. 19 receives input data such as data described by a page description language or the like, and temporarily converts it into intermediate codes before performing rendering processing to form an image.

The input data analysis unit 1 analyzes input data described by, e.g., a page description language, and classifies it according to rendering types. Herein, the input data falls into three categories: character, graphics, and image. The classified input data is, according to the respective types, passed to the character data processing unit 2, the graphics data processing unit 3, and the image data processing unit 4.

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At this time, the character data management unit 11 searches the font cache buffer 13 for the shape data of a character indicated by the character data, and if not found, requests the character data generation unit 12 to generate character shape data. The character data management unit 11 also manages the font cache buffer 13 and registers the character shape data generated by the character data generation unit 12 in the font cache buffer 13 also. At the time of registration, if there is no free space in the font cache buffer 13, character shape data registered in the font cache buffer 13 is deleted according to a predetermined algorithm to allocate a free space so that new character shape data is registered.

The character data generation unit 12 generates character shape data, based on the character data passed from the character data management unit 11. The font cache buffer 13 stores the character shape data generated by the character data generation unit 12 for reuse. By storing the character shape data in the font cache buffer 13, for the same character, character shape data need not be generated in the character data generation unit 12, so that character shape data can be rapidly obtained.

The intermediate code management unit 14 stores intermediate codes received from the character data management unit 11 and other processing units in the intermediate code buffer 15. Rendering processing is performed according to the intermediate codes stored in the intermediate code buffer 15, and a rendered image is stored in the band buffer 6. The intermediate code buffer 15 stores intermediate codes generated by an appropriate processing unit.

FIG. 21 is a flowchart showing a conventional procedure for processing character data. In S101, whether input data is character data is judged in the input data analysis unit 1, and if not character data, in step

expelling process different from an expelling algorithm held by a character data management part of the system is performed, satisfactory result cannot be obtained. Besides, to transfer character shape data from the font cache buffer 13 to the intermediate code buffer 15, all intermediate codes stored in the intermediate code buffer 15 must be checked as described above so that, for intermediate codes referencing the shape data of the transferred character, information for referencing the shape data is updated. For this reason, there has been the problem that processing speed decreases.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above circumstances and provides an image processing apparatus and an image processing method that enable efficient use of code information storage areas such as an intermediate code buffer and can rapidly process code information to render characters, and an image forming apparatus that employs such an image processing apparatus and image processing method.

A first aspect of the invention is an image processing apparatus and image processing method that, when code information indicating a character is inputted, stores reference information of shape data in a font storage part, used to reference the shape data of the character indicated by the code information, in a code information storage part, and stores reference information pointing to code information referencing the shape data of the character in the font storage part in association with the shape data of the character. Thereby, code information indicating individual characters forms a data structure for references to and from the shape data of the characters. Therefore, for example, even if character shape data is transferred from the code information storage part to the font storage part or

shape data stored in the font cache buffer and intermediate codes stored in the intermediate code buffer after fallback processing in the third embodiment of the image processing apparatus and image processing method of the present invention;

FIG. 19 is a block diagram showing an example of a general image forming apparatus;

FIG. 20 is a block diagram showing an example of a character data processing unit and an intermediate code processing unit;

FIG. 21 is a flowchart showing a conventional procedure for processing character data;

FIG. 22 is a schematic diagram showing the locations of character shape data in the font cache buffer and the intermediate code buffer when the conventional procedure for processing character data is executed;

FIG. 23 is a schematic diagram showing the locations of character shape data in the font cache buffer and the intermediate code buffer in another conventional method for processing character data;

FIG. 24 is a schematic diagram showing the locations of character shape data in the font cache buffer and the intermediate code buffer when there is no free space in the font cache buffer in another conventional method for processing character data; and

FIG. 25 is a schematic diagram showing the locations of character shape data in the font cache buffer and the intermediate code buffer when a free space occurs in the font cache buffer, in another conventional method for processing character data.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a block diagram showing a first embodiment of an image

to the flowchart shown in FIG. 2. The example shown in FIG. 6 shows the case where the shape data of the character "あ" already registered in the font cache buffer 13 is selected by a predetermined method and is saved to the intermediate code buffer 15.

The selected shape data of the character "あ", after the intermediate code buffer 15 is checked for free space capacity, is transferred from the font cache buffer 13 to the intermediate code buffer 15. The character shape data can be transferred to the intermediate code buffer 15. At the same time, according to information about reference to intermediate codes, added to the shape data of the character "あ", reference information for referencing the shape data of the character "あ", added to the intermediate codes, is updated. Thereby, a mutual reference relationship between the character shape data and the intermediate codes is maintained. Since such a mutual reference relationship is maintained, when the character shape data is transferred to the intermediate code buffer 15, reference information added to the intermediate codes can be updated based on reference information added to the character shape data. This eliminates the need to search the intermediate code buffer 15, enabling rapid expelling processing.

After the shape data of the character "あ" is thus transferred from the font cache buffer 13 to the intermediate code buffer 15, the font cache buffer 13 is checked for free space capacity, and if it is available for registration, the shaped data of the character "い" newly generated is stored in the font cache buffer 13. Information about references to and from an intermediate code to render the character "い" is written to the shape data and the intermediate code. This makes a state as shown in FIG. 6.

Character shape data expelled to the intermediate code buffer 15 is deleted, for example, at the point where no reference has been made from

intermediate codes. Or the character shape data is deleted when the intermediate code buffer 15 is updated each time an image is rendered in a specified unit such as one page.

If character shape data selected as shape data to be expelled from the intermediate code buffer 15 is not referenced from intermediate codes, it may be deleted from the font cache buffer 13 without being transferred to the intermediate code buffer 15.

In the process of the above-described expelling processing, the intermediate code buffer 15 may have no free space large enough to store character shape data to be expelled from the font cache buffer 13. The intermediate code buffer 15 may be filled in the course of registering intermediate codes in it regardless of characters. In such a case, fallback processing is performed to generate a free space in the intermediate code buffer 15.

FIG. 7A and 7B illustrate a first example of fallback processing. (1) to (4) in the figure designate objects to be rendered, respectively. FIG. 7A shows overlapped rendered objects. That is, the objects (1) and (2) are rendered before the object (3) overwrites the object (1), and then overwritten with the object (4).

As the objects are overwritten in this way, figures rendered according to the objects (1) to (3) are deleted by rendering the object (4). Accordingly, rendering results are equivalent to the case of rendering only the object (4) as shown in FIG. 7B. The description here assumes that the rendered objects are opaque.

Thus, earlier objects wholly contained in a rendering area of an object to be rendered later can be deleted because they need not be rendered. Taking advantage of this property, intermediate codes in such a relationship

15. In this way, the fallback processing can be performed.

FIG. 10 illustrates an example of the relationship between character shape data stored in the font cache buffer and intermediate codes stored in the intermediate code buffer after fallback processing in the first embodiment of the image processing apparatus and image processing method of the present invention. FIG. 10 shows the case where fallback processing has been performed because the intermediate code buffer 15 runs out of free space in the state shown in FIG. 3. In this example, fallback processing is performed by the method shown in FIG. 8 for intermediate codes in a portion from the top to a dashed line in the intermediate code buffer 15 in FIG. 10. That is, rendering processing is performed according to the intermediate codes in the portion from the top to a dashed line in the intermediate code buffer 15 in FIG. 10 to generate an intermediate rendered image. The rendered image is compressed to obtain a compressed image shown in the lower part of FIG. 10.

The intermediate codes having performed the rendering processing are deleted. Intermediate codes to render characters have a mutual reference relationship with character shape data. To delete the intermediate codes to render characters, reference information of character shape data referencing the intermediate codes to be deleted is changed to an invalid value as shown in FIG. 10. Or the reference information may be deleted. In this way, the reference relationship between the intermediate codes to be deleted and the character shape data is invalidated.

By performing the rendering processing sequentially to delete intermediate codes, a large free space is generated in the intermediate code buffer 15. In the vacated area are stored intermediate codes including reference information for referencing an intermediate rendered image or a

the shape data of a clipped character may also be stored in the font cache buffer 13, and during clipping in a fast-scanning direction, as in the case of the above-described split on band boundaries, processing may be performed to reference the shape data of characters not clipped.

FIG. 12 illustrates an example of the relationship between character shape data stored in the font cache buffer and intermediate codes stored in the intermediate code buffer after expelling processing in the second embodiment of the image processing apparatus and image processing method of the present invention. FIG. 12 shows that the shape data of the character "あ" is expelled in the state in FIG. 11 and stored in the intermediate code buffer 15.

In the second embodiment, the expelling processing can be very easily performed. That is, as shown in FIG. 12, after the shape data of the character "あ" is stored in the intermediate code buffer 15, the reference relationship is maintained by simply changing reference information of an intermediate code (the intermediate code stored at address a) referencing the shape data of the character "あ". The character shape data may be stored in the intermediate code buffer 15 while holding the same font, character code, and other information as it had when stored in the font cache buffer 13.

In this way, even when expelling processing has been performed, since reference information can be changed only in one intermediate code, processing can be performed faster than the conventional processing of searching the intermediate code buffer 15 and the case of changing reference information of plural intermediate codes as in the above-described first embodiment.

FIG. 13 illustrates an example of the relationship between character

reference information of intermediate codes and character shape data directly referenced by the intermediate codes to be deleted.

Also during ordinary rendering processing, the same processing as the above-described fallback processing can be performed for reference information added to character shape data and reference information added to intermediate codes. That is, for an intermediate code having performed character rendering processing, reference information of character shape data and an intermediate code, referenced by two pieces of reference information added to the intermediate code, is respectively updated. Thereby, the intermediate code having performed the rendering processing becomes deletable, removed from the mutual reference list. Or after rendering processing has been performed in a specified unit such as one page or one band, reference information added to character shape data and intermediate codes may be updated collectively.

FIG. 14 is a block diagram showing a third embodiment of the image processing apparatus of the present invention. Reference numbers in the figure are the same as those of FIG. 20. FIG. 14 also shows a configuration for implementing a third embodiment of the image processing method of the present invention. Also in the third embodiment, the character data management unit 11 and the intermediate code management unit 14 form a management unit. The intermediate code buffer 15 forms a code information storage part; the font cache buffer 13, a font storage part; and the character data generation unit 12, a character data generation part. Character data in FIG. 14 may be input data to render characters as described above or data corresponding to the above-described intermediate codes. Intermediate codes in FIG. 14 correspond to code information.

In the third embodiment, when character data is inputted, the

repeated once or plural times to allocate a free space large enough to register the character shape data newly generated in S143. If the font cache buffer 13 has a free space large enough to register the character shape data newly generated or has a free space as a result of the expelling processing, in S146, the character shape data newly generated is registered in the font cache buffer 13.

Before proceeding to the next step to store the character shape data in the intermediate code buffer 15, it is determined in S147 whether the character shape data can be stored in the intermediate code buffer 15. If the intermediate code buffer 15 has no free space large enough to store the character shape data, in S148, fallback processing is performed to create a free space in the intermediate code buffer 15. The fallback processing is performed as described in the above-described first embodiment.

When a free space exists in the intermediate code buffer 15 or after a free space is allocated by the fallback processing in S148, in S149, the character shape data stored in the font cache buffer 13 or the character shape data newly generated is stored in the intermediate code buffer 15. The character shape data is stored in the intermediate code buffer 15 while holding the same font, character code, and other information as it had when stored in the font cache buffer 13. In S150, the intermediate code including reference information for referencing the character shape data stored in the intermediate code buffer 15 is stored in the intermediate code buffer 15. This terminates processing for one piece of character data.

In this way, the shape data of a character indicated by inputted character data and the intermediate code including reference information for referencing the character shape data are stored in the intermediate code buffer 15. At this time, for the same character, only one piece of shape

data is stored in the intermediate code buffer 15 and intermediate codes using the character shape data are associated with reference information for referencing the character shape data. Therefore, a large number of pieces of the shape data of same characters are not put in the intermediate code buffer 15 as they have been in conventional intermediate code buffers, so that the intermediate code buffer 15 can be effectively used.

Although not shown in the above-described flowchart, if the intermediate code buffer 15 has no free space not only when character shape data is stored in the intermediate code buffer 15 but also when data is written to the intermediate code buffer 15, fallback processing is performed in S148 to increase the capacity of free space in the intermediate code buffer 15.

FIG. 16 illustrates an example of the relationship between character shape data stored in the font cache buffer and intermediate codes stored in the intermediate code buffer in the third embodiment of the image processing apparatus and image processing method of the present invention. As described above, in the third embodiment, character shape data is stored in the intermediate code buffer 15 aside from the font cache buffer 13. At this time, the character shape data to be stored in the intermediate code buffer 15 is provided with the same font, character code, and other information as it has when stored in the font cache buffer 13. To intermediate codes to render by using the character shape data, reference information for referencing the character shape data in the intermediate code buffer 15 is added. Thereby, as shown in FIG. 16, intermediate codes to render, e.g., the character "あ" are provided with reference information for referencing the shape data of the character "あ" in the intermediate code buffer 15 so that the intermediate codes can reference the shape data without

having the entity of the character shape data.

By adopting such a data structure, the font cache buffer 13 and the intermediate code buffer 15 can be managed independent of each other. Hence, without being influenced by a method for managing the font cache buffer 13, the intermediate code buffer 15 is reduced in the amount of data and can be effectively used.

When character shape data is split on band boundaries, as shown in FIG. 4, preferably, information such as width and height is added to intermediate codes, and split positions of the character shape data are held as reference positions. In the example shown in FIG. 16, for the shape data of a clipped character, the shape data of the clipped character is added to intermediate codes. Of course, for the shape data of a clipped character, as described above, the character shape data and the intermediate codes may be stored in the intermediate code buffer 15 and reference information for referencing the character shape data may be added to the intermediate codes. During clipping in a fast-scanning direction, as in the case of the above-described split on band boundaries, processing may be performed to reference the shape data of characters not clipped.

FIG. 17 illustrates an example of the relationship between character shape data stored in the font cache buffer and intermediate codes stored in the intermediate code buffer after expelling processing in the third embodiment of the image processing apparatus and image processing method of the present invention. As described above, in the third embodiment, the font cache buffer 13 and the intermediate code buffer 15 can be managed independent of each other. Therefore, where expelling processing is to be performed because the font cache buffer 13 runs out of free space, the conventional method is used by which character shape data of low priority is

deleted to register newly generated character shape data in a vacated area. In the expelling processing, no operation needs to be performed on the intermediate code buffer 15. Consequently, the expelling processing can be performed more easily and faster than in the above-described two embodiments.

FIG. 18 illustrates an example of the relationship between character shape data stored in the font cache buffer and intermediate codes stored in the intermediate code buffer after fallback processing in the third embodiment of the image processing apparatus and image processing method of the present invention. FIG. 18 shows an example that, because the intermediate code buffer 15 runs out of free space in the state in FIG. 16, fallback processing is performed, by the method described in FIG. 8, for intermediate codes stored above a dashed line in the intermediate code buffer 15 as shown in FIG. 18. That is, rendering processing is performed according to the intermediate codes in the portion from the top to the dashed line in the intermediate code buffer 15 in FIG. 18 to generate an intermediate rendered image. The rendered image is compressed to obtain a compressed image shown in the lower part of FIG. 18. An intermediate code including reference information for referencing the rendered image or compressed image is stored in the intermediate code buffer 15.

In the fallback processing, the intermediate codes having performed the rendering processing are deleted. Character shape data existing in an area subject to fallback processing is not deleted. Accordingly, even if intermediate codes existing in an area not subject to rendering processing reference character shape data, a reference relationship among them is not lost. Character shape data is subjected to rendering processing in a unit of, e.g., one page, and when the intermediate code buffer 15 is deallocated, an

area of the character shape data is also deallocated and becomes unusable.

As described above, in the third embodiment, character shape data is stored in the intermediate code buffer 15, and reference information for referencing the character shape data is associated with intermediate codes. Thereby, compared with the case where each intermediate code is provided with character shape data, the amount of intermediate codes is reduced and the intermediate code buffer 15 can be effectively used.

The above-described first or third embodiment can apply to, e.g., an image forming apparatus. In application to the image forming apparatus as shown in FIG. 19, as a character data processing unit 2 and an intermediate code processing unit 5, the image processing apparatus of the present invention may be incorporated or the image processing method of the present invention may be applied. Thereby, a memory to store intermediate codes can be effectively used and input data to render characters can be rapidly processed. Consequently, processing of the entire image forming apparatus can be sped up.

As has been described above, according to the present , character shape data is stored separately from code information and reference information for referencing the character shape data is added to the code information, whereby a data amount in the code information storage unit is reduced and the code information storage unit can be effectively used. To enable mutual references between the character shape data and each piece of code information, both of them can be provided with information for referencing each other. Thereby, for example, during expelling processing to transfer character shape data from the font storage unit to the code information storage unit, or fallback processing to increase a free space in the code information storage part, reference information of code information

